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Cost-Benefit Analysis of USAID/Liberia's Rice and Goat Value Chain Interventions

Final Report

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Final Report

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DISCLAIMER

The contents of this report are the sole responsibility of IDG and do not necessarily reflect the views of USAID or the United States Government.

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LIST OF ACRONYMS

CAHW	Community Animal Health Workers
CARI	Central Agricultural Research Institute
CBA	Cost-Benefit Analysis
DAI	Development Alternatives Inc.
ENPV	Economic Net Present Value
ERR	Economic Rate of Return
FED	Food and Enterprise Development
FEP	Foreign Exchange Premium
FNPV	Financial Net Present Value
FTF	Feed the Future
GoL	Government of Liberia
GST	Goods and Sales Tax
Ha	Hectare
IFDC	International Fertilizer Development Center
IIA	Integrated Investment Appraisal
IRR	Internal Rate of Return
LEAD	Liberian Entrepreneurial & Asset Development
LEAP	Learning Evaluation and Analysis Project
LRD	Liberian Dollar
MOA	Ministry of Agriculture
MOP	Muriate of Potash
MT	Metric Tones
NGO	Non-Governmental Organization

NPK	Nitrogen, Phosphorus and Potassium
NPV	Net Present Value
PV	Present Value
TSP	Triple Super Phosphate
USAID	United States Agency for International Development
VC	Value Chain

TABLE OF CONTENTS

List of Acronyms	iv
Table of Contents.....	vi
List of Tables	viii
List of Figures	ix
Executive Summary.....	1
Introduction.....	6
Project Description	6
Description of Interventions.....	6
Interventions in the rice value chain	7
Interventions in the goat value chain	8
Methodology and Model Description.....	9
Methodology	9
Model Description	9
Financial Analysis	11
Rice Value Chain	12
Goat Value Chain.....	14
Benefits for paddy producers	15
Benefits for Millers	16
Incremental Costs in the Rice Value Chain	16
Benefits of Interventions in the Goat Value Chain.....	17
Incremental Costs in the Goat Value Chain	18
Economic Analysis	20
Stakeholder Analysis	23
Sensitivity Analysis and Risk Variables	24
Rice Value Chain	24
Goat Value Chain.....	26

Conclusions and Recommendations	28
References	32
Annex A – Upland Paddy Producers Farm Budget	33
Annex B – Lowland Paddy Producers Farm Budget.....	36
Annex C – Annual Farm Budget for Goat Producers.....	39
Annex D – Foreign Exchange Premium	41
Annex E – Land Surface Affected by FED Project	42
Annex F – Stakeholders Interviewed	43
Rice Value Chain	43
Goat Value Chain.....	43
Annex G – Investment Cost of Goats Sites Construction	44
Annex H – Commodity Specific Economic Conversion Factors	45
Rice VC	45
Goat VC	45
Annex I – Sources of Inputs for Rice Model	46
Annex J – Sources of Inputs for Goat Model.....	50

LIST OF TABLES

Table 1: Incremental Economic Analysis of FED Project (USAID Perspective)	1
Table 2. Incremental Financial Analysis (USD).....	11
Table 3. Incremental Financial Analysis of Rice VC	12
Table 4. Financial Returns of “With-Project” Scenario (Little-No Market Access).....	12
Table 5. Incremental Financial Returns Without Subsidies on Inputs	13
Table 6. Incremental Financial Returns Without Subsidies on Inputs	14
Table 7. Summary of Incremental Costs in Rice VC (US\$/ha)	17
Table 8. Summary of incremental costs in Goat VC (US\$/goat/year)	18
Table 9. Incremental Economic Analysis of FED Project	20
Table 10. Incremental Economic Returns in the Rice VC	21
Table 11. Incremental Economic Returns in the Goat VC.....	22
Table 12. Distributive Analysis (USD millions)	23
Table 13. Impact of Change in Adoption Rates on ENPV, USAID Perspective (USD millions).....	24
Table 14. Change in Lowlands Expansion Rate, Without the Project (USE millions)	25
Table 15. Change in Paddy Yields with Project, Upland (USD millions)	25
Table 16. Change in Paddy Yields with Project, Lowlands (USD millions)	25
Table 17. Change in Kidding Interval, With Project (USD millions)	26
Table 18. Change in the Price Increase, With Project (US\$ millions)	26
Table 19. Change in the Buck-to-Doe Ratio, With Project (USD millions).....	27

LIST OF FIGURES

Figure 1: Effective post-conflict development framework	7
Figure 2: Benefits of USAID FED interventions at the paddy level	15
Figure 3: Benefits of USAID FED interventions for goat farmers.....	17

EXECUTIVE SUMMARY

Background. USAID has been supporting the development of agriculture and improvements in food security in many countries in sub-Saharan Africa through technical assistance under its Feed the Future (FtF) initiative. To evaluate these programs, USAID recently began a process of conducting cost benefit analyses (CBAs) of activities currently in process or completed. To support this process, USAID/Washington requested IDG, through the Learning, Evaluation, and Analysis Project-II (LEAP-II), to conduct several of these CBA activities. This report presents the findings of the CBA of USAID/Liberia's work with rice and goat value chains (VCs), specifically evaluating the recent FtF activities implemented under the Food and Enterprise Development program (FED).

USAID/Liberia's FED project falls within a larger portfolio of U.S. Government interventions in Liberia to improve food security through the FtF initiative. The project commenced in 2011 and will be completed in 2016, and it supports the Government of Liberia's (GoL's) dedication to agricultural development. FED utilizes the generalized "effective post-conflict economic development" framework while partnering with the GoL to enhance food security by creating an "indigenous incentive structure." This approach involves improving productivity technologies, resulting in increased use of improved and mechanized input supply and extension systems. It also aims to promote commercial production, marketing and processing. The FED project also aims to improve the value chains of staple crops including rice and cassava. It also plans to develop new value chains (vegetables and goat) and to improve the enabling environment for private sector investment in agriculture.

CBA Summary. The team conducted a CBA on a number of selected FED interventions. Interventions in the rice value chain include productivity improvement interventions, such as trainings on improved agronomic practices, and establishment of community mills, warehouses and power tillers. In the goat value chain, the CBA analyzed the establishment of goat management sites consisting of three shelters for goats (general, maternity and quarantine).

USAID's investment in the rice VC amounts to US\$ 19.53 million. The present value (PV) of this cost is US\$ 17.06 million, which is deducted from the PV of net economic benefits to calculate the Economic Net Present Value¹ (ENPV) of the FED project from the USAID perspective.² In the goat VC the USAID investment totals US\$ 4.61 million with the corresponding PV of US\$ 3.96 million. A summary of the economic analysis is presented in Table 1.

Table 1: Incremental Economic Analysis of FED Project (USAID Perspective)

Value Chain	ENPV (US\$ millions)	ERR
Rice Value Chain	(6.58)	8.6%
Goat Value Chain	(3.60)	1.5%
Total	(10.19)	7.6%

¹ In finance, the net present value (NPV) is defined as the sum of the present values (PVs) of incoming and outgoing cash flows over a period of time. Economic Net Present Value (ENPV) then looks at incoming and outgoing resources which are defined beyond just cash flows and are described as benefit and cost resource flows, respectively.

² The PV and NPVs are expressed as of 2012, the year after the FED project commenced. The ENPV is based on an assumption that only 40% of the product is sold. The break-even point is 68%. Above that amount the ENPV for rice turns positive.

CBA of Rice and Goat Value Chain Interventions. The ENPV of the FED project, once the USAID cost is included, is negative US\$ 10.19 million, indicating that the benefits of the interventions do not outweigh the costs. The Economic Rate of Return³ (ERR) is only 7.6 percent, which is 4.4 percent lower than the 12 percent threshold set by USAID.

The recent Ebola outbreak and other factors, including the high logistical costs in Liberia, contributed to the negative returns of FED interventions. The analysis, however, concludes the following factors had the most impact to negative returns:

1. The technology selected by the FED project results in high paddy yields. Such yields are significantly above the in-house consumption of an average Liberian household. However, there is limited access to markets (discussed below). The consequence is extremely high post-harvest losses.
2. The limited access to markets prevents the timely sale of paddy and increases post-harvest losses even further. The analysis, therefore, assumes that 40 percent of farmers can market their production. The negative rates of return for this product are highly sensitive to an assumed low rate of market sales. As discussed below, raising the share of rice produced that is sold to markets would yield positive rates of return.
3. The increase in the cost of farming activities along with almost no access to credit prevents farmers from continuing with the improved production technologies when the provision of free inputs from FED is not in place.

The main finding of this analysis is that farmers with no market access might not continue the FED project-promoted activities in the second year of the project, when the FED no longer provides free inputs. However, the group of project beneficiaries that do have access to markets will generate significant financial returns of 1,857 and 2,420 USD/hectare (ha) for upland and lowland rice production, respectively. Beneficiaries without market access will simply return to the pre-project practices, resulting in a very low adoption rate of the FED interventions (with the current analysis assuming a 40 percent adoption rate). The break-even point for the adoption rate is estimated at 68 percent. That is, over 68 percent of rice produced needs to be sold in order to generate positive net present values for the assistance.

Even if the opportunity cost of family labor is omitted from the analysis, the increase in the cost of inputs for paddy production ranges from US\$ 191 to US\$ 212 for upland and lowland rice, respectively. When the opportunity cost of family labor is considered, the total incremental cost increases to 352.10 US\$/ha. This is slightly below the US\$ 365.00 for the extreme poverty threshold, indicating that the majority of the Liberian farmers simply cannot afford such paddy cultivation technologies.

Very limited market access exacerbates the problem even further. The selected production technologies, although technically very efficient, are not financially feasible given the current context. Limited infrastructure and market access as well as the high cost of improved inputs

³ Internal Rate of Return (IRR) is the (break-even) interest rate at which investors can expect to receive positive returns. The Economic Rate of Return (ERR) differs from the Financial Rate of Return (FRR) in that it takes into account the effects of factors such as price controls, subsidies, and tax breaks to compute the actual cost of the project to the economy.

make it unlikely that farmers will continue to introduce new technologies without continued input subsidies and a readily accessible market to see beyond their own consumption.

The positive Financial Net Present Value (FNPV) of paddy production if farmers are able to sell the paddy indicates that there is a strong potential for scaling up project activities without providing the direct subsidy to a number of farmers if there is stable market access. In fact, a significant number of farmers may voluntarily change their production pattern once they observe success of their neighbors. In addition, the drastic increase in yields is likely to depress paddy prices, negatively affecting estimated financial returns. However, this is contingent on reliable access to markets.

How can rice interventions be modified to yield positive net present values? If rice farmers are able to sell a greater share of their product – over 68 percent break-even point according to our analysis – the interventions would yield positive net present values. Table 2 below shows the rate of return with improved market access.

To achieve these high sales levels, it is critical for USAID to analyze and understand why current sales levels are so low and what can be done to improve them. There is possible market demand in Monrovia that could be satisfied by rice producers up country in a financially profitable way, if conditions were to change. Possible factors to explore are:

- Increase coverage and improve rural primary and secondary roads to increase market access and decrease cost.
- Spread lower cost grid electricity to locations where mills will operate.
- Invest in sufficient mills to handle increased supply.

Table 2. Economic Returns with Improved Market Access (USAID Perspective)

Value Chain	ENPV ⁴ (US\$ millions)	ERR ⁵
Rice Value Chain	1.62	13%
Goat Value Chain	(3.6)	1.7%
Total	(1.95)	11.3%

The present analysis is a CBA of current interventions; it is not a comprehensive value chain analysis, so the above are merely suggestions for consideration. Further analysis is essential to better determine what additional complementary interventions might help raise sales, and, therefore, net present values of current rice value chain interventions.

⁴ In finance, the net present value (NPV) is defined as the sum of the present values (PVs) of incoming and outgoing cash flows over a period of time. Economic Net Present Value (ENPV) then looks at incoming and outgoing resources which are defined beyond just cash flows and are described as benefit and cost resource flows, respectively.

⁵ Internal Rate of Return (IRR) is the (break-even) interest rate at which investors can expect to receive positive returns. The Economic Rate of Return (ERR) differs from the Financial Rate of Return (FRR) in that it takes into account the effects of factors such as price controls, subsidies, and tax breaks to compute the actual cost of the project to the economy.

Benefits Power Tillers and Preparation of Abandoned Lowlands. The FNPV for paddy farmers with access to power tillers is 294 US\$/ha.⁶ This finding supports the strong demand for such services observed during the field trips. However, a more detailed analysis is required to see if investments in power tillers are financially feasible from a private investor's point of view when there is no subsidy from USAID.

The FNPV of abandoned land rehabilitation using FED-promoted practices is estimated at 2,345 US\$/ha, indicating that farmers with the access to markets are likely to adopt FED practices and invest in the initial preparation of abandoned lands. However, the FNPV of abandoned land rehabilitation without support from the FED project is negative 43.0 US\$/ha, which explains the ongoing reluctance of farmers to cultivate paddy on abandoned lands using traditional practices.

Benefits of Rice Mill Development. The nominal Internal Rate of Return (IRR) of investments for the establishment of private mills is 30 percent. This important finding indicates that private entrepreneurs that are willing to accept a 30 percent rate of return on their investment may be interested in making such investments. The cost of building, including the storage facilities, represents 90 percent of the investment cost. The buildings constructed by the FED project are based on international standards; though the cost of buildings constructed using locally available materials is unknown, one can reasonably argue that the cost will be lower. This implies that the financial returns are likely to be higher than 30 percent, providing on even bigger incentive to private investors.

CBA of Goat Value Chain Interventions.⁷ The FNPV of the interventions in the goat VC is only US\$ 51 per farmer. Such marginal financial returns stem from the significant cost increase required to boost production. The main cost drivers include salaries of livestock attendants and increased feeding costs at the management sites. Therefore, the overall outcome of the cost benefit analysis shows a negative ENPV of USAID's investment in the amount of \$3.60 million, as seen above in Table 1. However, as discussed, the FED project's support to the goat value chain focused on establishing goat management sites which used materials in line with international standards and supported improved nutrition and veterinary care in the shelters. The costs for development of the shelters are assumed to be extremely high for a typical farmer. The following conclusions and recommendations come from this analysis:

1. Based on the current observations and assumptions, the significant cost of USAID investments greatly outweighs the marginal positive financial gains of the goat farming activities under the current FED project as seen in the tables above.
2. There may be ways to reduce the costs of establishing the shelters with use of cheaper materials and farmer labor (if not already used). Reducing these costs would improve the overall outcome, although it would not be sufficient to result in an overall positive ENPV for USAID without other measures.
3. USAID might also want to evaluate the possibility of assisting farmers in producing secondary products such as milk and cheese. This may lead to a more positive economic outcome and a greater probability that farmers will invest in additional sites on their own

⁶ Assuming a service fee of 32.4 US\$/ha is all-in cost of the power tiller service.

⁷ The FED project provided support to a greater number of rice farmers than to goat farmers. Less information on the goat value chain was provided. Therefore, the CBA analysis to some extent provides a greater focus on the rice value chain.

after the project is gone. However, additional data would need to be collected on costs and benefits of these additional activities to evaluate their feasibility.

4. It is recommended to conduct a thorough value chain analysis for the rice and goats value chains. The analysis is necessary to determine the overall competitiveness of these value chains, identify key bottlenecks, and propose a clear path to improve the productivity and competitiveness of the value chains.

INTRODUCTION

PROJECT DESCRIPTION

The United States Agency for International Development (USAID) requested a cost-benefit analysis (CBA) of USAID/Liberia's Food and Enterprise Development (FED) project, implemented over the 2011-16 period. The USAID FED project aims to improve technology transfer that will enhance productivity and profitability, increase supply of improved agricultural inputs and extension, improve manpower development, expand the scale of production, and create a conducive environment for private sector investment in agriculture with special focus on women and youth.⁸ Of the four value chains (rice, goat, cassava and vegetable) selected for USAID FED activities, this assessment provides a CBA of the interventions implemented in the rice and goat value chains.

The USAID FED project supports of the Government of Liberia's (GoL's) dedication to agricultural development. FED utilizes the generalized "effective post-conflict economic development"⁹ framework with the objective of enhancing food security. Five partners – Development Alternatives Inc. (DAI), Winrock International, International Fertilizer Development Center (IFDC), Louisiana State University, and the Cadmus Group¹⁰ – are implementing the project. The three components of the FED project include:

1. Increase agricultural productivity, profitability and improve nutrition;
2. Encourage investment in private sector enterprise development; and
3. Improve indigenous technical and managerial skills, and human resources to sustain achievements made under objectives (a) and (b).¹¹

The team conducted the CBA on the basis of data and information collected through a literature review as well as interviews with FED staff and various stakeholders in Liberia. A detailed list of the stakeholders interviewed is provided in Annex A.

DESCRIPTION OF INTERVENTIONS

FED utilized the generalized "effective post-conflict economic development" framework (USAID Microlinks, 2015) with the objective of enhancing food security by creating an "indigenous incentive structure." This structure is built on the following pillars:

- a) Improved technology for productivity and profitability;
- b) Expanded use of improved and mechanized input supply and extension systems;
- c) Increased commercial production including marketing and processing; and
- d) Improved enterprise services and workforce development.

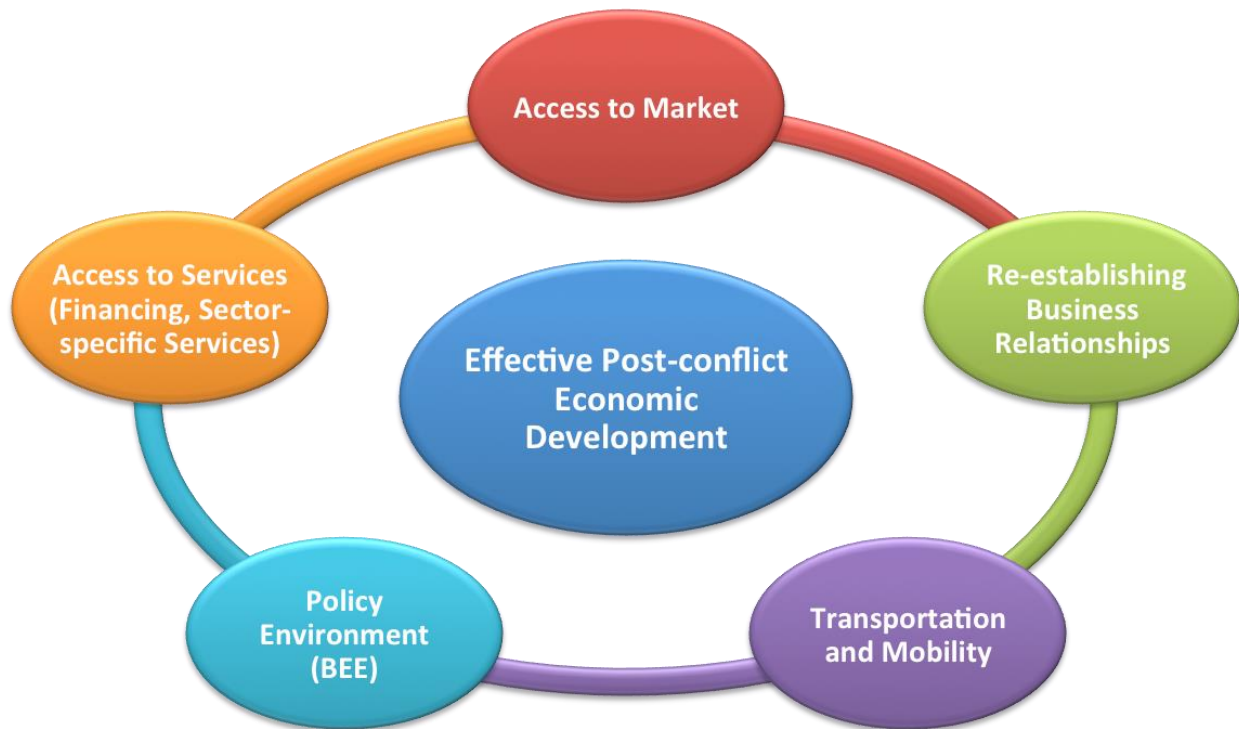
⁸ FED annual reports

⁹ Please refer to Figure 1 for visual presentation of "effective post-economic development" framework.

¹⁰ FED annual reports

¹¹ Wailes, E.J. (2015): Policy Sequencing Assessment for Liberia's Rice Value Chain

Figure 1: Effective Post-Conflict Development Framework¹²



Interventions in the rice value chain

The CBA evaluated three groups of FED project interventions according to three functional areas of activity:

1. Productivity improvement interventions:
 - Training of farmers on improved agronomic practices.
 - First year provision of improved production inputs such as certified seeds and fertilizers.
2. Establishment of business hubs:
 - Nine community rice mills were established in 2014. Another nine, constructed in 2015, are awaiting completion and commencement of operations. The business hubs also include storage facilities for paddy and rice. This has created the opportunity of absorbing surplus harvest and reduction of post-harvest losses. In addition, the FED project supported the recently-established first industrial rice mill (in Fabrar, Liberia).
3. Access to power tillers:¹³

¹² “The Value Chain Approach in Conflict-Affected Contexts” section, available online from: <https://www.microlinks.org/good-practice-center/value-chain-wiki/value-chain-approach-conflict-affected-contexts>.

¹³ The use of power tillers is limited to lowland production systems. Therefore, the analysis distinguishes provision of power tillers from the establishment of business hubs.

- Liberia has vast lowland areas that were cultivated before the war and then abandoned during and after the war. The initial preparation of these abandoned lands is highly labor intensive, preventing the expansion of paddy production. FED distributed a total of 30 power tillers to encourage mechanization and reduce the cost of land preparation. The provision of power tillers resulted in a total of 6,300 hectares of abandoned lowlands being prepared, developed, and planted.

Interventions in the goat value chain

FED interventions in the goat VC include:

1. **Funding and executing the MoA's national peste des petits ruminants (PPR) vaccination campaign in 2012.** The program was executed in six counties with the largest goat populations. About 100,000 goats were vaccinated during the exercise.
2. **Trainings on herd management.** In 2013, FED trained 36 Community Animal Health Workers (CAHWs) in diagnosis, treatment and veterinary pharmaceutical handling, use, and administration.
3. **Construction of animal shelters.** A total of 103 and 77 sites (three shelters per site – general, maternity and quarantine) were built in 2014 and 2015, respectively.
4. **Establishment of goat marketing hubs.** FED piloted marketing activity in Nimba that brought together goat producers and traders from various districts in the county. Special attention was paid to include traders from Monrovia in the event.

For the purpose of this CBA analysis, interventions 2, 3 and 4 were grouped into a single functional group under the theme of “production enhancement and market access.” The national PPR vaccination campaign was excluded from this analysis.

METHODOLOGY AND MODEL DESCRIPTION

METHODOLOGY

The Integrated Investment Appraisal (IIA) methodology is used to evaluate both the financial and the socio-economic effectiveness of FED interventions and assess their impacts from various perspectives. IIA is the only single-model approach to quantify the impact of every project-related transaction, from the investor (USAID) to tax revenues, fiscal expenditure, consumers, and the environment. Major development banks, donor agencies, and public investment units use this methodology in project evaluations.

The IIA of USAID's FED project begins with an evaluation of the profitability of the investment (financial module). This analysis is conducted on an incremental basis to determine the net incremental impact of the project on various stakeholders, including project beneficiaries, and to test the project's financial sustainability (please refer to Financial Analysis, beginning page 11).

The socio-economic assessment (economic module) builds on the financial, reducing the time and resources normally required for such studies (please refer to Economic Analysis, beginning page 20). The economic module is based on the principles of applied welfare economics,¹⁴ in which socio-economic benefits are assigned monetary values and assessed using typical investment project efficiency indicators, such as economic net present value (ENPV), analogous to financial net present value (FNPV), and economic rate of return (ERR), analogous to internal rate of return (IRR).

MODEL DESCRIPTION

The analysis is applied to a 20-year evaluation period, 2012-32, and compares “with-project” and “without-project” scenarios on an incremental basis, with real financial and economic discount rates set by USAID at 12 percent. The model is constructed on an annual basis with a base year of 2015. The results are expressed in 2012 prices. The model first derives nominal cash flows, which are then discounted using corresponding price indexes to derive real cash-flow statements. The analysis uses World Bank inflation and exchange rate data.

The rice VC Excel model closely follows analyzed FED interventions. The CBA is conducted for milling operations and paddy production. The Excel model is dynamic, where a change in a parameter affects the complete list of relevant stakeholders. For instance, reduction in paddy yields requires domestic consumers to shift toward imported rice. This means the GoL will need to import more rice to satisfy domestic demand and therefore will gain import duties, but these fiscal gains will be partially outweighed by foreign exchange premium¹⁵ (FEP) losses. The total land surface affected by the project is used to derive an aggregate economic resource flow statement.

¹⁴ See “Three Basic Postulates for Applied Welfare Economics”, A. Harberger, 1971.

¹⁵ Foreign Exchange Premium (FEP): The FEP captures the distortions created by the indirect taxes, trade tariffs and subsidies levied in the markets in which foreign exchange is used or generated. This premium is used as a component in converting the financial values of tradable and non-tradable inputs and outputs into their corresponding economic values.

The goat model is based on the capacity of animal shelters constructed by the FED project and the herd projection table, which uses technical parameters of the reproductive performance of goats to estimate the increase in live animal production due to the interventions. The total number of shelters constructed is used to derive an aggregate economic resource flow statement for the goat VC.

USAID investment costs are then compared with the net incremental economic benefits of the FED project to derive the net present value (NPV) of the USAID investment.

FINANCIAL ANALYSIS

Extensive desk research and analysis was carried out to review existing literature, including annual reports and other data from the FED project. The data used to model the “with” and “without” scenarios for the CBA of rice and goat value chains came from both primary and secondary sources. Primary sources include face-to-face interviews with stakeholders, including implementing partners. During field visits, the team hosted focus groups comprised of participating farmers (to determine their success factors and constraints) and non-participating farmers (as a control). Secondary data were sourced from existing data on ongoing FED and other studies as well as literature on previous studies in Liberia. A summary of the incremental financial analysis of the FED project is presented in Table 2.

Table 2. Incremental Financial Analysis (USD)

FED Beneficiaries	FNPV/Ha (USD)	IRR	Total FNPV (USD millions)
Upland paddy producers	1,857	35%	4.14
Lowland paddy producers	2,420	34%	4.47
Millers	40,017	NA	0.56
Goat Producers	521	13%	0.07
Total FNPV			9.24

The adoption of farming practices promoted by the FED project resulted in positive financial returns for paddy and goat farmers. Annual upland paddy producer income has increased to 302.0 US\$/ha “with-project,” compared to 52.0 US\$/ha in the “without-project” scenario. The incremental income is US\$ 250.0 per household. In the lowlands, annual income has increased even further, from 64.0 US\$/ha to 392.0 US\$/ha. The profitability of goat rearing also increased from 1,326 to 1,874 US\$/shelter.¹⁶

The expected aggregate incremental FNPV from the paddy farmers’ perspective is US\$ 4.47 and US\$ 4.14 million for the lowland and upland producers, respectively. It should be noted that such NPV only exists if farmers can consume or market all of their incremental production. The analysis assumes that production from only 1,845 ha of land will be marketed. Therefore, the baseline scenario assumes a 40 percent adoption rate of FED-supported practices.

The FNPV of the interventions in the goat VC is US\$ 51 per farmer. Such marginal financial returns are driven by the significant increase in the cost required to boost productivity. The main cost drivers include salaries of livestock attendants and increased feeding cost.

¹⁶ Shelters consist of three sections, general, maternity and quarantine. Each section has a capacity of 20 goats. The analysis assumes that the average occupancy of the shelter is 44 goats.

RICE VALUE CHAIN

Table 3, below, presents a summary of the incremental financial analysis of the FED project. It should be noted that the results presented in Table 3 are calculated assuming that the farmers will be able to market all the incremental production. However, the field visits revealed that market access is still very limited. Liberia has vast lowland areas that were cultivated before the war and then abandoned during and after the war. The main challenge to stimulate a move from traditional, upland production systems to adopt high productivity strategies in lowland rice production is limited access to markets, which results in the Liberian farmers' lack of motivation to produce beyond consumption.¹⁷

Table 3. Incremental Financial Analysis of Rice VC

FED Beneficiaries	FNVP/Ha (USD)	IRR	Total FNVP (USD millions)
Upland paddy producers	1,857	35%	4.14
Lowland paddy producers	2,420	34%	4.47
	FNVP/Mill (USD)		
Millers	40,017	NA	0.56
		Total FNVP	9.16

Adoption of highly productive cultivation strategies implies increased farm level expenditures to purchase production inputs such as fertilizers. Even making a generous assumption of availability of financial resources to cover the increased expenses, farmers that lack market access will continue to bear these expenditures only if increased in-house consumption outweighs the costs. The analysis, therefore, makes an optimistic assumption that farmers with limited market access will be able to market or consume only 30 percent of their incremental production. The financial returns of the FED project suggested practices with no/or limited market access are presented in Table 4.

Table 4. Financial Returns of “With-Project” Scenario (Little-No Market Access)

FED Beneficiaries	FNVP/Ha (USD)	IRR
Upland paddy producers	(612)	-1 %
Lowland paddy producers	(1,450)	-5%

¹⁷ The FED project annual work plan for 2015.

An important conclusion from this analysis is that farmers with no market access will not continue the FED-promoted activities in the second year of the project when the FED project stops providing free inputs. Therefore, project beneficiaries that have access to markets will generate significant financial returns of 1,857 and 2,420 USD\$/ha for upland and lowland rice production, respectively. The rest of the beneficiaries will simply return to previous practices, resulting in a low adoption rate. The current analysis assumes an adoption rate of 40 percent. The low adoption rate is based on several assumptions:

1. All the farmers interviewed were concerned with market access because they were unable to sell a significant part of their production the previous year.
2. Assuming that mills operate on an average of 65-70 percent of their capacity, which is the case in Senegal where the milling industry is relatively developed, the mills are able to absorb only 55-60 percent of the production.
3. The main concern is the incremental cost of US\$ 300 per hectare, which is simply not affordable for Liberian farmers. Therefore, farmers will not continue the new production practices when free inputs from the project are no longer available.

The 40 percent adoption rate also results in a negative ENPV once USAID FED costs are included (USAID perspective). The break-even point for the adoption rate is estimated at 68 percent.

In the first year, the FED project distributed improved seeds, fertilizers and other inputs to support improved production with no charge to the project beneficiaries. This strategy aims to convince farmers that benefits of suggested production practices justify the increased production costs, though limited market access can potentially jeopardize the entire effort. The potential financial returns of the suggested production practices when the subsidy is not in place are presented in Table 5.

Table 5. Incremental Financial Returns Without Subsidies on Inputs

Paddy Producers	FNPV/Ha (USD)	IRR
Upland paddy producers	1,633	23%
Lowland paddy producers	2,219	25%

The positive FNPV of paddy production if farmers are able to sell the paddy indicates that there is a strong potential for scaling up project activities without providing the direct subsidy to a number of farmers. In fact, a significant number of farmers may voluntarily change their production patterns once they observe success of their neighbours. However, this is only valid if there is stable access to markets. In addition, the drastic increase in yields is likely to depress paddy prices, negatively affecting estimated financial returns.

The analysis assumes that 20 percent of lowland FED project beneficiaries also have access to power tillers provided by the project.¹⁸ The FNPV of farmers without and with access to power tillers is estimated at 2,561 and 2,855 US\$/ha, respectively. The FNPV for the paddy farmers that have access to power tillers is, therefore, 294 US\$/ha.¹⁹

The FNPV of abandoned lowlands rehabilitation is estimated at 2,404 US\$/ha, indicating that farmers with access to markets are likely to adopt FED practices and invest in initial preparation of abandoned lands. In addition, the FNPV of the rehabilitation of abandoned lowlands is negative 43.0 US\$/ha, which explains the ongoing reluctance of farmers to cultivate paddy on abandoned lowlands using traditional practices.

The field visits revealed that millers on average utilize approximately 70 percent of production capacity. This observation is also consistent with the average capacity utilization of similar millers in Senegal. The FNPV of an individual miller is estimated at 40,017 US\$/ha. The aggregate FNPV is US\$ 0.56 million. The FNPV is relatively high because the FED project entirely subsidizes the investment cost. When no subsidy is present, the FNPV is only 12,611 US\$/mill.

The nominal IRR of investments in the establishment of private mills is 30 percent. This important finding indicates that private entrepreneurs that are willing to accept a 30 percent rate of return on their investment may be interested in making such investments. The cost of building including the storage facilities represents 90 percent of the investment cost. The buildings constructed by the FED project are based the international standards. Although the cost of construction using locally available materials is unknown, one can reasonably argue that the cost will be lower. This implies financial returns are likely to be higher than 30 percent, providing even bigger incentives to private investors.

GOAT VALUE CHAIN

The FED project has invested in the construction of 180 goat sites with each site made of three shelters. In addition to the construction of the shelters, a selected number of farmers were trained to become Community Animal Health Workers (CAHWs). Although there was significant improvement in the productivity of goat farming, the increased costs almost outweigh the benefits of the interventions. Table 6 presents the incremental financial returns of the goat VC interventions.

Table 6. Incremental Financial Returns Without Subsidies on Inputs

Scenarios	FNPV/Site (USD thousands)	IRR	Total FNPV (USD millions)
Without scenario	10.37	NA	1.42
With scenario	10.89	21%	1.49
Incremental	0.52	13%	0.07

¹⁸ FED project Annual Report for 2015.

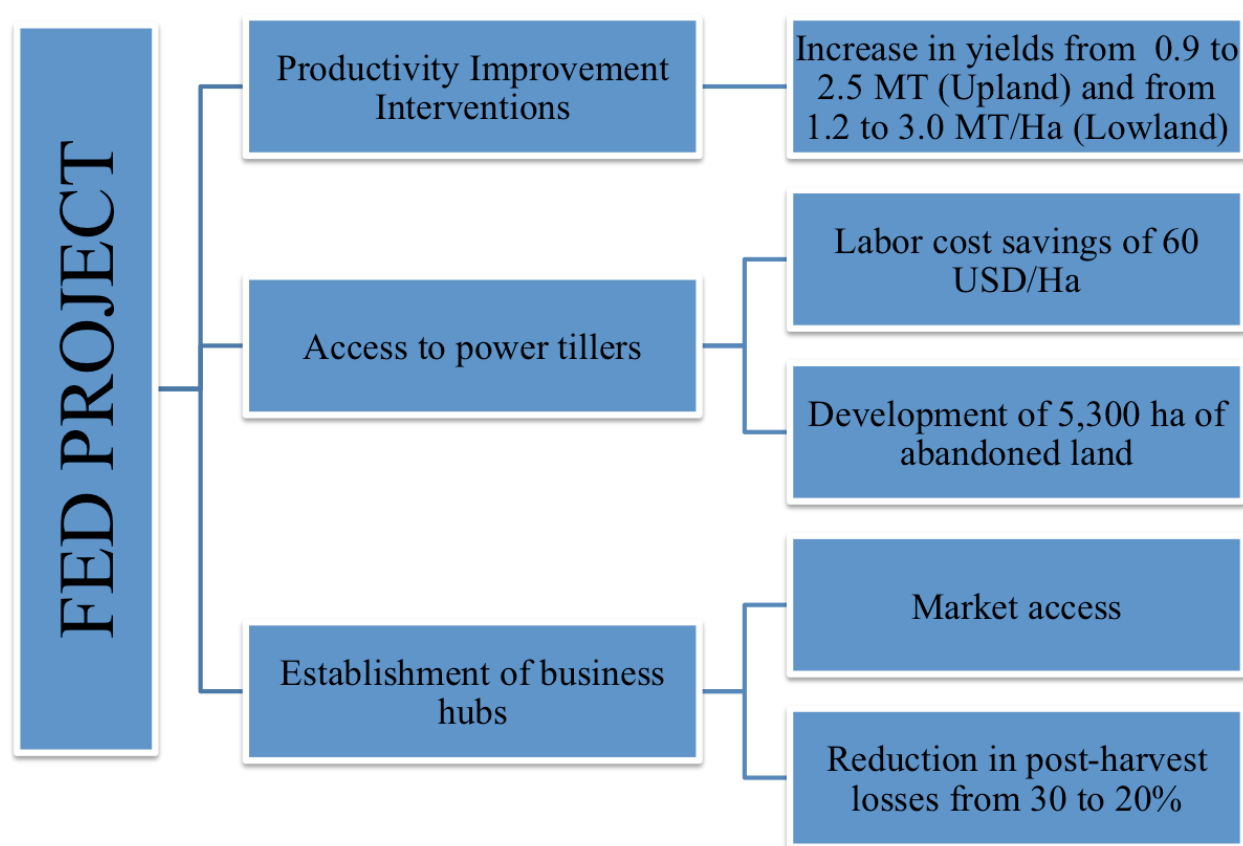
¹⁹ Assuming the service fee of 32.4 US\$/ha is all-in cost of the power tiller service.

The IRR is estimated at 12.8 percent with a marginal FNPV of 521.0 US\$/site. It should be noted that animal shelters were constructed in line with international standards. Additional analysis is required to estimate financial returns if the shelters are constructed with the use of local materials. The sensitivity analysis section will present the change in financial returns if the cost of the shelter construction decreases.

BENEFITS FOR PADDY PRODUCERS

Interventions to improve productivity, mechanization, private sector involvement and market access resulted in six major gains for paddy farmers. These gains are summarized in Figure 2.

Figure 2: Benefits of USAID FED Interventions at the Paddy Level



The productivity improvement group of interventions resulted in an increase in average yields from 0.9 MT/ha in the “without project scenario” to 2.5 MT/ha (with project) in the upland production system. In the lowland system the average yield under traditional cultivation practices is 1.2 MT/ha. The average yield using improved practices suggested by the FED project is 3.0 MT/ha. This CBA, however, treats the expansion of paddy cultivation in the lowlands as a Greenfield production. The analysis assumes that a moderate rate of expansion (along with population growth) of two percent will prevail in the absence of the project.

In addition, in the first year the FED project provided improved inputs to the farmers. This was meant to convince farmers of the financial feasibility of production using improved inputs. This first year subsidy, by itself, is a large benefit for the farmers. However, the analysis revealed that, without market access, investment in improved inputs is not financially or economically feasible, resulting in low adoption rates. This finding is in line with field observations and the literature review. Absence of stable markets is the main challenge facing Liberian rice farmers and results in a lack of incentive to produce beyond consumption. This finding also drives the negative total returns of FED project. Details are provided in the following sections.

Rural areas of Liberia are characterized by the scarcity of labor. The shortage of labor dictates relatively high wage rates, particularly during the agricultural season, of LRD 250/day (US\$ 2.70). As it takes 35 labor days to prepare/plough a hectare of land, the cost of manual land preparation is 94.6 US\$/ha. Access to power tillers' services²⁰ at a fee of 32.4 US\$/ha reduces the cost of land preparation by approximately US\$ 60.0. In addition, access to power tillers provides farmers with the confidence that they will be able to plough an increased land surface. This has resulted in an additional 5,320 ha of new lands prepared as of the end of 2015. An additional 1,000 ha are expected to be prepared in 2016.

Establishment of 19 mills with the installed capacity of 6 MT/day/mill provided relatively stable access to markets for 40 percent²¹ of project paddy producers. Market access not only allows farmers to sell increased production, but also results in a decrease in post-harvest losses from 30 percent to 20 percent.

Benefits for Millers

The establishment of 19 milling centers not only provided farmers with an opportunity to sell increased production, but it also allowed private entrepreneurs, who received milling equipment as a grant, to generate the profits. The annual income from the milling operations amounts approximately 6,067 US\$/mill.

INCREMENTAL COSTS IN THE RICE VALUE CHAIN

The FED project is introducing highly productive paddy cultivation technologies that result in the tripling of paddy yields. These technologies, however, imply significant increase in financial cost of farming. Table 7 presents the summary of incremental farm level expenditures. Even when the cost of family labor is not considered, the increase in the expenditures range from US\$191 to US\$212 for upland and lowland, respectively. Given the low purchasing power of an average Liberian farmer and very limited access to lending mechanisms, such an increase in the cost is anticipated to result in extremely low adoption rates. When the opportunity cost of family labor is considered, the total incremental cost increases up to 352.1 US\$/ha. This is slightly below the US\$ 365.00 threshold for extreme poverty, indicating that a majority of the Liberian farmers simply cannot afford such technology.

²⁰ Power tillers were granted to private entrepreneurs to provide the services for a charge.

²¹ The assumption of 40% has to be confirmed by the FED implementer.

Table 7. Summary of Incremental Costs in Rice VC (US\$/ha)

Cost	Upland paddy producers	Lowland paddy producers
Seeds	64.6	13.51
Fertilizers	129.7	157.84
Bags for paddy	17.2	19.46
Total without Labor	211.5	190.8
Labor	140.5	159.5
Total with Labor	352.1	350.3

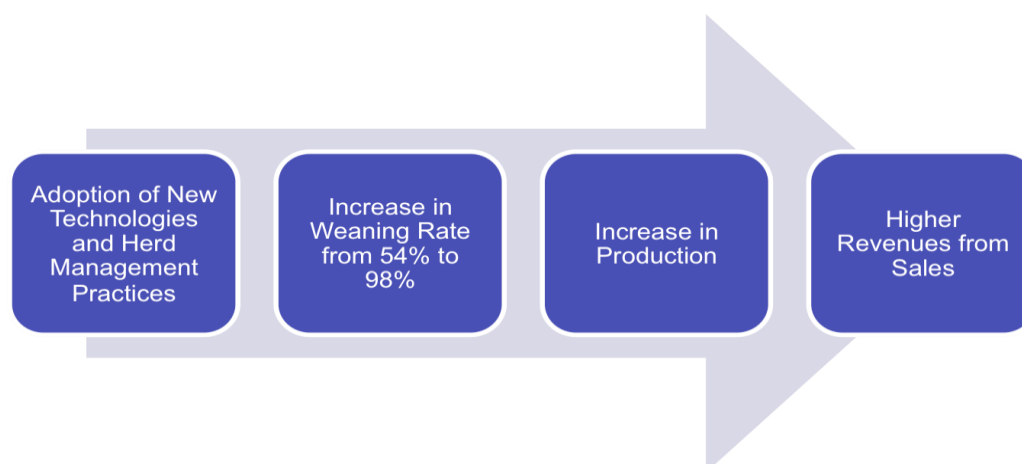
In addition, the cost of initial preparation of abandoned lowlands is 270 US\$/ha. This cost is high enough to prohibit expansion to lowlands once the FED project is over.

The very limited market access exacerbates the problem even further. Although the selected production technology is technically very efficient, it is financially not feasible given the current situation in Liberia where the marketability of production is a major challenge. The analysis, therefore, recommends that USAID combine investments in production with investments in markets and infrastructure.

BENEFITS OF INTERVENTIONS IN THE GOAT VALUE CHAIN

The USAID FED project has positively impacted the goat value chain through adoption of new technologies and herd management practices. The impacts are summarized in Figure 3.

Figure 3: Benefits of USAID FED Interventions for Goat Farmers



Construction of animal shelters, trainings of Communal Animal Health Workers, introduction of herd management practices, and fattening resulted in a number of benefits:

1. Kidding interval²² has, on average, been reduced from 11 to 9 months, increasing the kidding rate from 109 to 133 percent per year.
2. A shift toward a 1:10 ratio of buck to does increased animal production.
3. Although FED implementers report an increase in weaning rates from 54 to 98 percent, the 2 percent mortality rate for kids seems to be unreasonably low. The analysis, therefore, assumes an increase in the weaning rate from 54 to 78 percent and gradually to 90 percent in a three-year period.
4. The intensive three weeks of feeding prior to sale increases the price of the animals by an average of 20 percent.

INCREMENTAL COSTS IN THE GOAT VALUE CHAIN

The traditional approach of goat keeping in Liberia does not involve any financial expenditure. The animals are generally given minimal attention. Farmers typically provide cassava leaves and edible household waste to goats in the evenings, and no veterinary care is provided. The goats are sold only when cash is required, resulting in very low commercial off-take rates.

The FED interventions in the goat VC are designed to convert traditional animal husbandry into a commercial activity, where goats are kept in a shelter and provided water and feed. An intensive feeding interval of 21 days takes place prior to delivering the goats to markets for sale. Mainly bucks are sold and does are kept for reproduction. The incremental costs of such production are presented in Table 8 below.

Table 8. Summary of incremental costs in Goat VC (US\$/goat/year)

Cost	US\$
Feeding	4.2
Veterinary expenses	2.0
Intensive feeding	5.7
Labor²³	35.9
Total	47.7

²² The gestation period for the West African dwarf (WAD) goat is roughly 5 - 5.5 months, with a three-month interval in between pregnancies. So, we assumed a kidding interval of nine months in project-supported herds. These species are very prolific with a non-seasonal breeder showing the possibility to kid approximately five times in three years.

²³ Labor cost is calculated by dividing the annual cost of labors and average site occupancy.

The cost of feeding of US\$ 4.2/goat is not a financial outlay; rather, it is an opportunity cost of labor to collect increased requirements of cassava leaves and other feeds. The cost of labor is the major expense aside from the cost of the animal shelter construction. However, the overall increase in the cost is rather moderate, which explains willingness of farmers to keep the animals in the shelters.

ECONOMIC ANALYSIS

The financial analysis outlined above forms the basis for an economic assessment of FED interventions, examining the incremental costs and benefits of project activities in terms of their broader impact on society. However, market prices frequently do not correspond to the actual value of resources produced and consumed in the course of a given activity due to distortions such as taxes and subsidies. The GoL exempts rice from import duties. However, there is a 2.5 percent import duty for certified seeds. The import duty of 2.5 percent also is applied to fertilizers. The paddy bags are subject to a 15 percent import duty. A Goods and Sales Tax (GST) is also applied on all inputs and outputs of the production. The foreign exchange premium for Liberia is estimated at 10.53 percent.²⁴

The analysis presented here uses commodity-specific conversion factors to adjust cash flows to derive the net resource flows for paddy and goat farming. The net resource flows are then scaled up according to the number of FED beneficiaries that are assumed to adopt the technologies to capture total net economic benefit.²⁵

USAID investment in the rice VC amounts to US\$19.53 million. The PV of this cost is US\$ 17.06 million, which is deducted from the PV of net economic benefits to calculate the ENPV of the FED project from the USAID perspective.²⁶ In the goat VC, USAID investment amounts US\$ 4.61 million with the corresponding PV of US\$ 3.96 million. A summary of the economic analysis is presented in Table 9.

Table 9. Incremental Economic Analysis of FED Project
(USAID perspective)

Value Chain	ENPV (US\$ mill)	ERR
Rice Value Chain	(6.58)	8.6%
Goat Value Chain	(3.60)	1.5%
Total	(10.19)	7.6%

The ENPV of the FED project once the USAID cost is included is negative US\$ 10.19 million, indicating that the benefits of the interventions do not outweigh the costs. The ERR is only 7.6 percent, which is 4.4 percent lower than the threshold of 12 percent set by USAID.

The analysis revealed that FED interventions result in negative returns of US\$ 10.19 million from a USAID perspective. The recent Ebola outbreak and other factors, including high logistics costs in Liberia due to poor infrastructure conditions, may contribute to the negative returns of FED interventions. The analysis, however, concludes that four key factors are:

²⁴ Please refer to Annex D for FEP calculation.

²⁵ See Annex I for a complete set of conversion factors used in the analysis.

²⁶ The PV and NPVs are expressed as of 2012, the year the FED project commenced.

1. Technologies selected by the FED project result in very high paddy yields. Such yields are significantly above the in-house consumption of an average Liberian household. If farmers with higher yields cannot market their surpluses, they will incur losses due to the inability to sell.
2. Limited access to markets prevents timely sale of paddy and increases post-harvest losses even further.
3. A drastic increase in the cost of farming activities along with almost no access to credit will prevent farmers from continuing the improved production when the provision of free inputs from the FED project is not in place.
4. The significant cost of USAID investments greatly outweighs the marginal positive financial gains of goat farming activities.

Table 10 presents incremental economic returns for the rice VC.

Table 10. Incremental Economic Returns in the Rice VC

FED Beneficiaries	ENPV/Ha (USD)	ERR	Total ENPV (USD millions)
Upland paddy producers	2,021	36%	4.50
Lowland paddy producers	2,607	34%	4.81
Medium millers		NA	1.17
<i>Total ENPV</i>			10.48
<i>PV of USAID Investments</i>			17.06
<i>ENPV USAID's Perspective</i>			(6.58)
<i>ERR USAID's Perspective</i>			9%

Economic gains to Liberia from FED activities in the rice VC are estimated at US\$ 10.48 million. These gains, however, are more than offset by the PV of USAID investment cost of US\$17.06 million. The ENPV from the USAID perspective is negative at US\$ 6.58 million. The ERR is 9 percent, which is 3 percent below the threshold.

Table 11. Incremental Economic Returns in the Goat VC.

	ENPV/Site (000's USD)	ERR	Total ENPV (USD millions)
Goat production	2.61	16%	0.36
<i>PV of USAID Investments</i>			3.96
<i>ENPV USAID's Perspective</i>			(3.60)
<i>ERR USAID's Perspective</i>			1.5%

Table 11 presents incremental economic returns for the goat VC. Economic gains to Liberia from FED activities in the goat VC are marginal, at US\$ 0.36 million. These gains are drastically lower than the PV of USAID investment cost. The ENPV from the USAID perspective is negative at US\$ 3.60 million. The ERR is 1.5 percent, which is more than 10 percent below the threshold.

STAKEHOLDER ANALYSIS

The social analysis of the project estimates the distribution of income changes caused by the project. This distributive analysis includes the reconciliation of financial, economic, and distributional appraisals, as well as identifies project impacts on principal objectives of the society concerned. There are four main stakeholders associated with the FED project:

1. Paddy farmers
2. Goat farmers
3. Government of Liberia
4. USAID

The financial gains to farmers are reported as the corresponding FNPV in the financial analysis section. Taxes collected on the importable inputs of the production represent a fiscal gain to the GoL. This gain, however, is outweighed by a high FEP of 10.31 percent for most of the inputs. The opposite takes place for the importable outputs of farming activities (paddy and goat). The gains in FEP due to reduced importation are almost outweighed by the losses in import duties. The PV of fiscal gains is therefore moderate at US\$1.68 million over the 20-year period. The bulk of the gains to the GoL are due to FEP savings from reduced imports of paddy and goat.

Table 12 displays that Liberian stakeholders are benefiting from USAID interventions. However, the cost of these interventions is greater than the resulting benefits.

Table 12. Distributive Analysis (USD millions)

Stakeholders	PV of Gains/Losses
Upland paddy producers	4.14
Lowland paddy producers	4.47
Medium millers	0.56
Goat farmers	0.07
Government of Liberia	1.60
USAID	(21.02)
Total	(10.19)

SENSITIVITY ANALYSIS AND RISK VARIABLES

The team carried out a sensitivity analysis to analyze the impact of changes to the main assumptions/parameters on deterministic returns of the FED project. The sensitivity analysis was conducted on key variables. While some of the variables are presented below, more sensitivity tables can be seen in the Excel model that accompanies this report.

RICE VALUE CHAIN

For the rice value chain, a sensitivity analysis was conducted for the following variables:

- Change in the adoption rate of FED production technologies;
- Change in annual expansion rate of using abandoned lowlands in the without project scenario;
- Change in paddy yields in the with project scenario;

**Table 13. Impact of Change in Adoption Rates on ENPV, USAID Perspective
(USD millions)**

		Adoption rate in upland areas						
(6.58)		40%	50%	60%	70%	80%	90%	100%
Adoption rate in lowland area	40%	(6.58)	(5.46)	(4.33)	(3.21)	(2.08)	(0.96)	0.17
	50%	(5.38)	(4.26)	(3.13)	(2.00)	(0.88)	0.25	1.37
	60%	(4.18)	(3.05)	(1.93)	(0.80)	0.32	1.45	2.57
	70%	(2.98)	(1.85)	(0.73)	0.40	1.52	2.65	3.78
	80%	(1.78)	(0.65)	0.48	1.60	2.73	3.85	4.98
	90%	(0.57)	0.55	1.68	2.80	3.93	5.05	6.18
	100%	0.63	1.75	2.88	4.01	5.13	6.26	7.38

The sensitivity analysis was conducted in two ways to see the joint impact of the adoption rates of farmers in lowlands and uplands simultaneously. The ENPV reaches its maximum of US\$ 7.38 million if the adoption rate is 100 percent both for upland and lowland farmers. However, this scenario is possible only if the farmers are able to sell their entire incremental production. Given the 300 percent increase in production, the price of paddy is likely to fall once market access is insured. Therefore, the economic returns are likely to be lower even if a 100 percent adoption rate is assumed.

Table 14. Change in Lowlands Expansion Rate, Without the Project (USE millions)

	Aggregate FNPV (USD millions)	Aggregate ENPV (USD millions)	
	Lowland	Economy	USAID
	4.47	10.48	(6.58)
0.0%	4.47	10.48	(6.58)
5.0%	2.57	8.43	(8.63)
10.0%	1.82	7.63	(9.43)
15.0%	1.98	7.79	(9.26)
20.0%	1.90	7.71	(9.35)
25.0%	1.11	6.87	(10.19)

Population growth is likely to force households to start cultivating paddy on previously abandoned lowlands. Although the baseline analysis assumes a 0 percent expansion rate in the “without” project scenario; once the assumption is stressed the economic returns become even more negative.

Table 15. Change in Paddy Yields with Project, Upland (USD millions)

		Aggregate FNPV (USD millions)	Aggregate ENPV (USD millions)	
		Upland	Economy	USAID
Paddy yield before post-harvest losses (Kg/Ha)		4.14	10.48	(6.58)
2,500	-20%	1.08	7.31	(9.75)
2,656	-15%	1.84	8.10	(8.96)
2,813	-10%	2.61	8.89	(8.17)
2,969	-5%	3.37	9.68	(7.38)
3,125	0.00%	4.14	10.48	(6.58)

Table 16. Change in Paddy Yields with Project, Lowlands (USD millions)

		Aggregate FNPV (USD millions)	Aggregate ENPV (USD millions)	
		Lowland	Economy	USAID
Paddy yield before post-harvest losses (Kg/Ha)		4.47	10.48	(6.58)
3,000	-20%	1.43	7.33	(9.73)
3,188	-15%	2.19	8.11	(8.94)
3,375	-10%	2.95	8.90	(8.16)
3,563	-5%	3.71	9.69	(7.37)
3,750	0.00%	4.47	10.48	(6.58)

Highly productive practices promoted by the FED project more than tripled yields in lowland and upland rice production in Liberia. Although such a significant increase in the yield was confirmed by the FED implementers as well as during the field visits, it is likely that most of the farmers will not be able to achieve such high yields. If yields are reduced by only 20 percent, FNPV decreases from US\$ 4.47 million to US\$ 1.43 million for lowlands and from US\$ 4.14 million to US\$ 1.08 million for uplands. Such a high sensitivity of financial and economic returns to the yields can be explained by the high cost of the cultivation practices promoted by the FED project.

GOAT VALUE CHAIN

The team conducted a sensitivity analysis for variables in the goat value chain including:

- a) Change in the kidding interval;
- b) Change in price increase resulting from intensive feeding; and
- c) Change in buck-to-doe ratio

Table 17. Change in Kidding Interval, With Project (USD millions)

	Aggregate FNPV (USD millions)	Aggregate ENPV (USD millions)	
	Goat farmers	Economy	USAID
	0.07	0.36	(3.60)
8	0.56	0.85	(3.11)
9	0.07	0.36	(3.60)
10	(0.32)	(0.04)	(4.00)
11	(0.63)	(0.36)	(4.32)

The analysis assumes the kidding interval improved, on average, from 11 to 9 months due to better nutrition and animal care. Financial and economic returns are highly sensitive to change in this parameter, indicating it should be monitored closely. An increase from 9 to 10 months results in negative returns, but a decrease to 8 months improves intervention returns.

Table 18. Change in the Price Increase, With Project (US\$ millions)

	Aggregate FNPV (USD millions)	Aggregate ENPV (USD millions)	
	Goat farmers	Economy	USAID
	0.07	0.36	(3.60)
10.00%	(0.12)	0.16	(3.80)
15.00%	(0.02)	0.26	(3.70)
20.00%	0.07	0.36	(3.60)
25.00%	0.17	0.45	(3.51)
30.00%	0.26	0.55	(3.41)
35.00%	0.36	0.64	(3.32)

Numerous factors affect the price of livestock; therefore, the team could not identify a price increase resulting from the 21-day intensive feeding of goats prior to sale. The analysis assumes that the intensive feeding results in a 20 percent price premium. The sensitivity analysis reveals that the price returns of FED interventions are highly sensitive to the price premium.

Table 19. Change in the Buck-to-Doe Ratio, With Project (USD millions)

	Aggregate FNPV (USD millions)	Aggregate ENPV (USD millions)	
	Goat farmers	Economy	USAID
	0.07	0.36	(3.60)
7.00	(0.07)	0.21	(3.75)
8.00	(0.01)	0.27	(3.69)
10.00	0.07	0.36	(3.60)
12.00	0.13	0.42	(3.54)
15.00	0.19	0.48	(3.48)
18.00	0.23	0.52	(3.44)
20.00	0.26	0.54	(3.42)

The FED project advises farmers to maintain a 1 to 10 buck-to-doe ratio in the short run. By mid-project, according to FED expectations, farmers will achieve a 1 to 20 ratio. In this case, the financial returns will increase from US\$0.07 million to US\$0.26 million, implying a moderate increase in profitability. However, it is important to note that a change in the buck-to-doe ratio simply changes the herd composition and does not affect its size. Because the number of animals remains the same, a change in the ratio does not imply any incremental costs at the farm level.

CONCLUSIONS AND RECOMMENDATIONS

The ENPV of FED project once the USAID cost is included is a negative US\$ 10.19 million, indicating that the benefits of the interventions do not outweigh the costs. The ERR is only 7.6 percent, which is 4.4 percent lower than the 12 percent threshold set by USAID.

The recent Ebola outbreak and other factors, including the high logistical costs in Liberia, contributed to the negative returns of FED interventions. The analysis, however, concludes the following factors had the most impact to negative returns:

1. The technology selected by the FED project results in high paddy yields. Such yields are significantly above the in-house consumption of an average Liberian household. However, there is limited access to markets (discussed below). The consequence is extremely high post-harvest losses.
2. The limited access to markets prevents the timely sale of paddy and increases post-harvest losses even further. The analysis, therefore, assumes that 40 percent of farmers can market their production. The negative rates of return for this product are highly sensitive to an assumed low rate of market sales. As discussed below, raising the share of rice produced that is sold to markets would yield positive rates of return.
3. The increase in the cost of farming activities along with almost no access to credit prevents farmers from continuing with the improved production technologies when the provision of free inputs from FED is not in place.

The main finding of this analysis is that farmers with no market access might not continue the FED project promoted activities in the second year of the project, when the FED no longer provides free inputs. However, the group of project beneficiaries that do have access to markets will generate significant financial returns of 1,857 and 2,420 USD/ha for upland and lowland rice production, respectively. Beneficiaries without market access will simply return to the pre-project practices, resulting in a very low adoption rate of the FED interventions (with the current analysis assuming a 40 percent adoption rate). The break-even point for the adoption rate is estimated at 68 percent. That is, over 68 percent of rice produced needs to be sold in order to generate positive net present values for the assistance.

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Even if the opportunity cost of family labor is omitted from the analysis, the increase in the cost of inputs for paddy production ranges from US\$ 191 to US\$ 212 for upland and lowland rice, respectively. When the opportunity cost of family labor is considered, the total incremental cost increases to 352.10 US\$/ha. This is slightly below the US\$ 365.00 for the extreme poverty threshold, indicating that the majority of the Liberian farmers simply cannot afford such paddy cultivation technologies.

Very limited market access exacerbates the problem even further. The selected production technologies, although technically very efficient, are not financially feasible given the current context. Limited infrastructure and market access as well as the high cost of improved inputs make it unlikely that farmers will continue to introduce new technologies without continued input subsidies and a readily accessible market to see beyond their own consumption.

The positive Financial Net Present Value (FNPV) of paddy production if farmers are able to sell the paddy indicates that there is a strong potential for scaling up project activities without providing the direct subsidy to a number of farmers if there is stable market access. In fact, a significant number of farmers may voluntarily change their production pattern once they observe success of their neighbors. In addition, the drastic increase in yields is likely to depress paddy prices, negatively affecting estimated financial returns. However, this is contingent on reliable access to markets.

How can rice interventions be modified to yield positive net present values? If rice farmers are able to sell a greater share of their product – over 68 percent break-even point according to our analysis – the interventions would yield positive net present values. Table 2 below shows the rate of return with improved market access.

To achieve these high sales levels, it is critical for USAID to analyze and understand why current sales levels are so low and what can be done to improve them. There is possible market demand in Monrovia that could be satisfied by rice producers up country in a financially profitable way, if conditions were to change. Possible factors to explore are:

- Increase coverage and improve rural primary and secondary roads to increase market access and

Table 2. Economic Returns with Improved Market Access (USAID Perspective)

Value Chain	ENPV ²⁷ (US\$ millions)	ERR ²⁸
Rice Value Chain	1.62	13%
Goat Value Chain	(3.6)	1.7%
Total	(1.95)	11.3%

²⁷ In finance, the net present value (NPV) is defined as the sum of the present values (PVs) of incoming and outgoing cash flows over a period of time. Economic Net Present Value (ENPV) then looks at incoming and outgoing resources which are defined beyond just cash flows and are described as benefit and cost resource flows, respectively.

²⁸ Internal Rate of Return (IRR) is the (break-even) interest rate at which investors can expect to receive positive returns. The Economic Rate of Return (ERR) differs from the Financial Rate of Return (FRR) in that it takes into account the effects of factors such as price controls, subsidies, and tax breaks to compute the actual cost of the project to the economy.

decrease cost.

- Spread lower cost grid electricity to locations where mills will operate.
- Invest in sufficient mills to handle increased supply.

The present analysis is a CBA of current interventions; it is not a comprehensive value chain analysis, so the above are merely suggestions for consideration. Further analysis is essential to better determine what additional complementary interventions might help raise sales, and, therefore, net present values of current rice value chain interventions.

Benefits Power Tillers and Preparation of Abandoned Lowlands. The FNPV for paddy farmers with access to power tillers is 294 US\$/ha.²⁹ This finding supports the strong demand for such services observed during the field trips. However, a more detailed analysis is required to see if investments in power tillers are financially feasible from a private investor's point of view when there is no subsidy from USAID.

The FNPV of abandoned land rehabilitation using FED-promoted practices is estimated at 2,345 US\$/ha, indicating that farmers with the access to markets are likely to adopt FED practices and invest in the initial preparation of abandoned lands. However, the FNPV of abandoned land rehabilitation without support from the FED project is negative 43.0 US\$/ha, which explains the ongoing reluctance of farmers to cultivate paddy on abandoned lands using traditional practices.

Benefits of Rice Mill Development. The nominal Internal Rate of Return (IRR) of investments for the establishment of private mills is 30 percent. This important finding indicates that private entrepreneurs that are willing to accept a 30 percent rate of return on their investment may be interested in making such investments. The cost of building, including the storage facilities, represents 90 percent of the investment cost. The buildings constructed by the FED project are based on international standards; though the cost of buildings constructed using locally available materials is unknown, one can reasonably argue that the cost will be lower. This implies that the financial returns are likely to be higher than 30 percent, providing on even bigger incentive to private investors.

CBA of Goat Value Chain Interventions.³⁰ The FNPV of the interventions in the goat VC is only US\$ 51 per farmer. Such marginal financial returns stem from the significant cost increase required to boost production. The main cost drivers include salaries of livestock attendants and increased feeding costs at the management sites. Therefore, the overall outcome of the cost benefit analysis shows a negative ENPV of USAID's investment in the amount of \$3.60 million, as seen above in Table 1. However, as discussed, the FED project's support to the goat value chain focused on establishing goat management sites which used materials in line with international standards and supported improved nutrition and veterinary care in the shelters. The costs for development of the shelters are assumed to be extremely high for a typical farmer. The following conclusions and recommendations come from this analysis:

²⁹ Assuming a service fee of 32.4 US\$/ha is all-in cost of the power tiller service.

³⁰ The FED project provided support to a greater number of rice farmers than to goat farmers. Less information on the goat value chain was provided. Therefore, the CBA analysis to some extent provides a greater focus on the rice value chain.

5. Based on the current observations and assumptions, the significant cost of USAID investments greatly outweighs the marginal positive financial gains of the goat farming activities under the current FED project as seen in the tables above.
6. There may be ways to reduce the costs of establishing the shelters with use of cheaper materials and farmer labor (if not already used). Reducing these costs would improve the overall outcome, although it would not be sufficient to result in an overall positive ENPV for USAID without other measures.
7. USAID might also want to evaluate the possibility of assisting farmers in producing secondary products such as milk and cheese. This may lead to a more positive economic outcome and a greater probability that farmers will invest in additional sites on their own after the project is gone. However, additional data would need to be collected on costs and benefits of these additional activities to evaluate their feasibility.
8. It is recommended to conduct a thorough value chain analysis for the rice and goats value chains. The analysis is necessary to determine the overall competitiveness of these value chains, identify key bottlenecks, and propose a clear path to improve the productivity and competitiveness of the value chains.

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ANNEX A – UPLAND PADDY PRODUCERS

FARM BUDGET

2015 Farm Budget for Upland Paddy Producers – Without Project (LRD/Ha)

Item	Quantity	Value per Unit (LRD)	LRD/Ha	Source
Revenues				
Paddy (Kg/Ha)	910	35	31,850	Interviews with farmers; M&E data of the project; USAID Micro-report #157 (2009). “Global Food Security Response Liberia Rice Study”
Total Revenues			31,850	
Costs				
Cost of Inputs				
Recycled seeds (Kg/Ha)	80	35	2,800	Interviews with farmers
Fertilizer - NPK (Kg/Ha)	-	80	-	Interviews with farmers and input suppliers; M&E data from the project
Bags for paddy (Bags/Ha)	19	50	950	Interviews with farmers and input suppliers; M&E data from the project
Rental cost of land	1	2,000	2,000	Interviews with farmers
<i>Total cost of inputs</i>			<i>5,750</i>	
Cost of Labor				
Land preparation	25	250	6,250	Interviews with farmers and M&E data from the project
Planting activities	40	250	10,000	Interviews with farmers and M&E data from the project
Harvesting	15	250	3,750	Interviews with farmers and M&E data from the project
Threshing	5	250	1,250	Interviews with farmers and M&E data from the project

Item	Quantity	Value per Unit (LRD)	LRD/Ha	Source
<i>Total cost of labor</i>			21,250	
Total Costs			27,000	
Net Income			4,850	

2015 Farm Budget for Upland Paddy Producers – With Project (LRD/Ha)

Item	Quantity	Value per Unit (LRD)	LRD/Ha	Source
Revenues				
Paddy (Kg/Ha)	2,500	35	87,500	Interviews with farmers; M&E data from the project; USAID Micro-report #157 (2009). “Global Food Security Response Liberia Rice Study”
Total Revenues			87,500	
Costs				
Cost of Inputs				
Improved seeds (Kg/Ha)	65	135	8,775	Interviews with farmers and input suppliers; M&E data from the project
Fertilizer - NPK (Kg/Ha)	150	80	12,000	Interviews with farmers and input suppliers; M&E data from the project
Bags for paddy (Bags/Ha)	50	50	2,500	Interviews with farmers and input suppliers; M&E data from the project
Rental cost of land	1	2,000	2,000	Interviews with farmers
<i>Total cost of inputs</i>			25,275	
Cost of Labor				
Land preparation	30	250	7,500	
Planting activities	60	250	15,000	
Harvesting	36	250	9,000	
Threshing	11	250	2,750	

Item	Quantity	Value per Unit (LRD)	LRD/Ha	Source
<i>Total cost of labor</i>			34,250	
Total Costs			59,525	
Net Income			27,975	

ANNEX B – LOWLAND PADDY PRODUCERS

FARM BUDGET

2015 Farm Budget for Lowland Paddy Producers – Without Project (LRD/Ha)

Item	Quantity	Value per Unit (LRD)	LRD/Ha	Source
Revenues				
Paddy (Kg/Ha)	1,190	35	41,650	Interviews with farmers; M&E data from the project; USAID Micro-report #157 (2009). “Global Food Security Response Liberia Rice Study”
Total Revenues			41,650	
Costs				
Cost of Inputs				
Recycled seeds (Kg/Ha)	80	35	2,800	Interviews with farmers
Fertilizer - Urea (Kg/Ha)	-	110	-	Interviews with farmers and input suppliers; M&E data from the project
Fertilizer - MOP (Kg/Ha)	-	80	-	Interviews with farmers and input suppliers; M&E data from the project
Fertilizer - TSP (Kg/Ha)	-	90	-	Interviews with farmers and input suppliers; M&E data from the project
Bags for paddy (Bags/Ha)	24	50	1,200	Interviews with farmers and input suppliers; M&E data from the project
Rental cost of land	1	2,000	2,000	Interviews with farmers
<i>Total cost of inputs</i>			<i>6,000</i>	
Cost of Labor				
Land preparation	35	250	8,750	Interviews with farmers and M&E data from the project
Maintenance of irrigation	10	250	2,500	Interviews with farmers and M&E data from the project
Transplanting and other	50	250	12,500	Interviews with farmers and M&E data from the project
Harvesting	18	250	4,500	Interviews with farmers and M&E data from the project

Item	Quantity	Value per Unit (LRD)	LRD/Ha	Source
Threshing	6	250	1,500	Interviews with farmers and M&E data from the project
<i>Total cost of labor</i>			29,750	
Total Costs			35,750	
Net Income			5,900	

2015 Farm Budget for Lowland Paddy Producers – With Project (LRD/Ha)

Item	Quantity	Value per Unit (LRD)	LRD/Ha	Source
Revenues				
Paddy (Kg/Ha)	3,000	35	105,000	Interviews with farmers; M&E data from the project; USAID Micro-report #157 (2009). “Global Food Security Response Liberia Rice Study”
Total Revenues			105,000	
Costs				
Cost of Inputs				
Recycled seeds (Kg/Ha)	30	135	4,050	Interviews with farmers
Fertilizer - Urea (Kg/Ha)	70	110	7,700	Interviews with farmers and input suppliers; M&E data from the project
Fertilizer - MOP (Kg/Ha)	30	80	2,400	Interviews with farmers and input suppliers; M&E data from the project
Fertilizer - TSP (Kg/Ha)	50	90	4,500	Interviews with farmers and input suppliers; M&E data from the project
Bags for paddy (Bags/Ha)	60	50	3,000	Interviews with farmers and input suppliers; M&E data from the project
Rental cost of land	1	2,000	2,000	Interviews with farmers
<i>Total cost of inputs</i>			<i>23,650</i>	
Cost of Labor				
Land preparation*	40	250	9,350	Interviews with farmers and M&E data from the project
Maintenance of irrigation channels	20	250	5,000	Interviews with farmers and M&E data from the project
Transplanting and other activities	70	250	17,500	Interviews with farmers and M&E data from the project
Harvesting	40	250	10,000	Interviews with farmers and M&E data from the project
Threshing	13	250	3,250	Interviews with farmers and M&E data from the project
<i>Total cost of labor</i>			<i>45,100</i>	
Total Costs			68,750	

Item	Quantity	Value per Unit (LRD)	LRD/Ha	Source
Net Income			36,250	

*Not mechanized

ANNEX C – ANNUAL FARM BUDGET FOR GOAT PRODUCERS

2015 Farm Budget for Goat Producers – With Project (LRD/Ha)

Item	Quantity	Value per Unit (LRD)	LRD/Ha	Source
Revenues				
Sales of Does	35.60	5,088	181,133	Quantities: model projections; Prices: interviews with goat producers and M&E data from the project
Sales of Bucks	38.12	5,550	211,566	Quantities: model projections; Prices: interviews with goat producers and M&E data from the project
Sales of Culled Does	2.00	4,394	8,788	Quantities: model projections; Prices: interviews with goat producers and M&E data from the project
Sales of Culled Bucks	0.20	4,394	879	Quantities: model projections; Prices: interviews with goat producers and M&E data from the project
Total Revenues			402,366	
Costs				
Feeding costs				
Cassava leaves and other forages (LRD/Day/Head)	98	1.00	35,682	Interviews with goat producers and M&E data from the project
Multivitamin & anti-worm drugs (LRD/Year/Head)	98	27.75	2,713	Interviews with goat producers and M&E data from the project
Other medical drugs & services (LRD/Year/Head)	98	157.25	15,373	Interviews with goat producers and M&E data from the project
Salt licks (LRD/Year/Head)	98	23.13	2,261	Interviews with goat producers and M&E data from the project

Item	Quantity	Value per Unit (LRD)	LRD/Ha	Source
Cost of intensive feeding for 21 days (LRD/Day/Head)	38	25.00	20,013	Interviews with goat producers and M&E data from the project
Shelter costs				
Shelter maintenance costs	1	6,947	6,947	M&E data from the project
Labor costs				
Caretaking, feeding and security (LRD/Day)	2	200	146,000	Interviews with goat producers
Total Costs			228,988	
Net Income			173,377	

ANNEX D – FOREIGN EXCHANGE PREMIUM

Tariff Revenues	<i>Mill USD</i>	111.7	151.9	152.0	153.5	155.2	
Export Taxes	<i>Mill USD</i>	-	-	-	-	-	
Export Subsidies	<i>Mill USD</i>	-	-	-	-	-	
Value of Imports	<i>Mill USD</i>	709.8	1,044.2	1,076.4	1,210.9	979.4	
Value of Exports	<i>Mill USD</i>	222.0	367.0	444.4	543.7	560.8	
Average FEP	10.31%	%	11.99%	10.76%	9.99%	8.75%	10.08%

- Source: Central Bank of Liberia
- $FEP = (\text{Tariff revenues} - \text{Export taxes} + \text{Export subsidies}) / (\text{Value of exports} + \text{Value of imports})$

ANNEX E – LAND SURFACE AFFECTED BY FED PROJECT

Hectares of Upland and Lowland Rice Supported by USAID Project*

Production System	County	Year		
<i>Upland Rice</i>		2013	2014	2015
	Bong	1,644	1,600	2,030
	Nimba	14	90	182
	Lofa	15	129	420
	Grand Bassa	2	44	333
Total		1,675	1,863	2,965
<i>Lowland Rice</i>				
	Bong	328	757	1,655
	Nimba	35	405	836
	Lofa	40	150	969
	Grand Bassa	15	44	86
Total		418	1,356	3,546

Source: USAID FED Data (2015)

Note: The numbers include demonstration sites

ANNEX F – STAKEHOLDERS INTERVIEWED

RICE VALUE CHAIN

1. Agricultural input suppliers: Gro-Green; Greenfield
2. Microfinance institution: LEAD
3. Village saving and loan associations (VSLAs)
4. Rice seed producer farm: Gausi farm, Nimba county
5. Upland and lowland farmers, including males and females from Nimba, Lofa, Bong counties
6. Power tiller operators
7. Industrial rice processor: FABRAR
8. Community-based millers
9. Rice distributors/retailers/aggregators
10. AfricaRice
11. CARI (Center of Agricultural Research Institute)
12. Ministry of Agriculture (MoA)

GOAT VALUE CHAIN

1. BRAC (Goat VC NGO)
2. Cow factory goat traders at Monrovia
3. Goat farmers, including project beneficiaries and non-beneficiaries from Nimba, Bong and Lofa counties
4. Agro-pharmacists and CAHWs (Community animal health workers)
5. Quarantine facility at CARI

ANNEX G – INVESTMENT COST OF GOATS

SITES CONSTRUCTION

Investment cost for establishing a Goat Site with 3 Shelters using local materials

Item (materials)	Quantity	Unit cost (US\$)	Total cost (US\$)	Life span (years)
Galvanized fence wire	10	125.00	1,250.00	7
Zinc iron sheets for roofing	5	80.00	400.00	6
Wire nails (2’')	2 cartons	30.00	60.00	6
Wire nails (3’')	2 cartons	30.00	60.00	6
Wire nails (4’')	2 cartons	30.00	60.00	6
Wire nails (5’')	2 cartons	30.00	60.00	6
Zinc nails	2 cartons	30.00	60.00	6
Drinker	3	10.00	30.00	2
Wood (2x2x14)	225	2.00	450.00	5
Wood (2x6x14)	50	4.00	200.00	5
Wood (1x12x14)	70	5.00	350.00	5
Wood (4x4x14)	50	5.00	250.00	5
Hinges	10	2.50	25.00	6
Carpenter fees	1	500.00	500.00	
Total building cost			3,755.00	

Source: USAID FED Data (2015)

ANNEX H – COMMODITY SPECIFIC ECONOMIC CONVERSION FACTORS

RICE VC

Item	Conversion Factor
Seeds (Importable Input)	0.99
Rice (Importable Output)	1.03
Fertilizer (Importable Input)	0.99
Fuel (Importable Input)	0.87
Bags (Importable Input)	0.89
Agricultural Equipment (Importable Input)	0.93
CF for land	1
CF for labor	1
CF for transportation	0.87
CF for Building	0.94

GOAT VC

Item	Conversion Factor
Goats (Importable output)	1.01
Veterinary drugs (Importable input)	0.97
Veterinary services	0.98
Salt (Importable input)	0.95
Cassava	1.00
Animal feeds and concentrate	0.97
CF for transportation	0.87
Shelter construction	0.95
CF for labor	1.00

ANNEX I – SOURCES OF INPUTS FOR RICE MODEL

General Inputs	
Input	Source
Yield growth rate without project (Cell F81)	Assumption
Average in-house consumption (Cell F83)	Interviews with farmers
Increase in in-house consumption with project (Cell F84)	Assumption
Prices and wage rate (Cell F86 to F97)	<ul style="list-style-type: none"> • Interviews with farmers • M&E data from the project • Interviews with agriculture input suppliers • USAID Micro-report #157 (2009). “Global Food Security Response Liberia Rice Study”
Upland Production (Without Project)	
Paddy yield before post-harvest losses (Cell F102)	Calculated based on the post-harvest losses and the yield after post-harvest losses
Post-harvest losses without project (Cell F103)	<ul style="list-style-type: none"> • Interviews with farmers • FED 2015 annual report • Discussions with the project’s M&E team
Paddy yield after post-harvest losses (Cell F104)	<ul style="list-style-type: none"> • Interviews with farmers • M&E data from the project • USAID Micro-report #157 (2009). “Global Food Security Response Liberia Rice Study”
Input requirements (Cell F106 & F107)	<ul style="list-style-type: none"> • Interviews with farmers • M&E data from the project
Bags for paddy (Cell F108)	Function of yield
Labor requirements (Cell F110 to F113)	<ul style="list-style-type: none"> • Interviews with farmers • M&E data from the project • USAID Micro-report #157 (2009). “Global Food Security Response Liberia Rice Study”

Labor requirement – Threshing (Cell F114)	Function of yield
Upland Production (With Project)	
Land surface affected – Upland (Cell I118 to M118)	M&E data of the project
Paddy yield before post-harvest losses (Cell F120)	Calculated based on the post-harvest losses and the yield after post-harvest losses
Post-harvest losses with project (Cell F122)	<ul style="list-style-type: none"> • Interviews with farmers • FED 2015 annual report • Discussions with the project's M&E team
Paddy yield after post-harvest losses (Cell F123)	<ul style="list-style-type: none"> • Interviews with farmers • M&E data from the project • USAID Micro-report #157 (2009). “Global Food Security Response Liberia Rice Study”
Input requirements (Cell F125 & F126)	<ul style="list-style-type: none"> • Interviews with farmers • M&E data from the project
Bags for paddy (Cell F128)	Function of yield
Labor requirements (Cell F129 to F132)	<ul style="list-style-type: none"> • Interviews with farmers • M&E data from the project • USAID Micro-report #157 (2009). “Global Food Security Response Liberia Rice Study”
Labor requirement – Threshing (Cell F133)	Function of yield
Lowland Production (Without Project)	
Lowland expansion rate without project (Cell F137)	Assumption
Paddy yield before post-harvest losses (Cell F139)	Calculated based on the post-harvest losses and the yield after post-harvest losses
Paddy yield after post-harvest losses (Cell F141)	<ul style="list-style-type: none"> • Interviews with farmers • M&E data from the project • USAID Micro-report #157 (2009). “Global Food Security Response Liberia Rice Study”
Input requirements (Cell F143 & F146)	<ul style="list-style-type: none"> • Interviews with farmers

	<ul style="list-style-type: none"> • M&E data of the project
Bags for paddy (Cell F147)	Function of yield
Labor requirements (Cell F149 to F153)	<ul style="list-style-type: none"> • Interviews with farmers • M&E data from the project • USAID Micro-report #157 (2009). “Global Food Security Response Liberia Rice Study”
Labor requirement – Threshing (Cell F154)	Function of yield
Lowland Production (With Project)	
Expansion with project (Cell I158 to M158)	M&E data from the project
Paddy yield before post-harvest losses (Cell F160)	Calculated based on the post-harvest losses and the yield after post-harvest losses
Paddy yield after post-harvest losses (Cell F163)	<ul style="list-style-type: none"> • Interviews with farmers • M&E data from the project • USAID Micro-report #157 (2009). “Global Food Security Response Liberia Rice Study”
Input requirements (Cell F165 & F168)	<ul style="list-style-type: none"> • Interviews with farmers • M&E data from the project
Bags for paddy (Cell F169)	Function of yield
Labor requirements (Cell F171 to F177)	<ul style="list-style-type: none"> • Interviews with farmers • M&E data from the project • USAID Micro-report #157 (2009). “Global Food Security Response Liberia Rice Study”
Labor requirement – Threshing (Cell F178)	Function of yield
Farmers with access to power tillers (Cell F182)	M&E data from the project
Milling Equipment	
No. of milling equipment installed (Cell I186 to L186)	M&E data from the project

All parameters (Cell F189 to F209)	<ul style="list-style-type: none"> Interviews with millers (2 millers were interviewed) Wailes, E. J. (2015). “Addendum to Policy Sequencing Assessment for Liberia’s Rice Value Chain”. FED USAID/Liberia.
Macroeconomic Indicators	
US inflation rate (Cell F215)	IMF ³¹
Price index – US (Cell F216)	Function of US inflation
Liberia inflation rate (Cell F217)	IMF
Price index – Liberia (Cell F218)	Function of Liberia inflation
Relative Price Index (Cell F219)	Function of US and Liberia price index
Official nominal exchange rate (Cell I221 to L221)	WB (http://data.worldbank.org/indicator/PA.NUS.FCRF)
Real exchange rate (Cell F222)	2015 is the base year and therefore the nominal exchange rate is equal to real exchange rate.
Nominal exchange rate (Row 224)	Function of real exchange rate and relative price index
Goods and services tax – GST (Cell F225)	Various sources
Discount rate (Cell F226)	USAID guidelines
EOCK (Cell F227)	USAID guidelines
FEP (Cell F228)	Calculated based on the data extracted from: <ul style="list-style-type: none"> Government of Liberia Annual Fiscal Outturn Reports Central Bank of Liberia Annual Reports

³¹<http://www.imf.org/external/pubs/ft/weo/2015/02/weodata/weorept.aspx?pr.x=36&pr.y=7&sy=2013&ey=2020&scsm=1&ssd=1&sort=country&ds=.&br=1&c=722&s=PCPIPCH&grp=0&a=>

ANNEX J – SOURCES OF INPUTS FOR GOAT MODEL

General Inputs	
Input	Source
Without Project	
Kidding interval (Cell F70)	<ul style="list-style-type: none"> Interviews with goat producers M&E data from the project
Average litter size (Cell F71)	<ul style="list-style-type: none"> Ministry of Agriculture (2014). “Liberia National Livestock Policy And Action Plan” M&E data from the project
Labor (Cell F85 & F86)	Interviews with goat producers
Weaning rate (Cell F89)	<ul style="list-style-type: none"> Ministry of Agriculture (2014). “Liberia National Livestock Policy And Action Plan” M&E data from the project
Mortality rate (Cell F90)	Assumption
Does and bucks (Cell F93 & F94)	Assumption
Offspring sex ratio – female and male (Cell F99 & F100)	<ul style="list-style-type: none"> Interviews with goat producers M&E data from the project
Culling rate – bucks and does (Cell F102 & F103)	Assumption
Animal feeding units (Cell F105 & F106)	Assumption
Selling prices (Cell F108 to F110)	<ul style="list-style-type: none"> Interviews with goat producers M&E data from the project
With Project	
Site capacity (Cell F119)	Assumption

Number of sites (Cells I120 to M120)	M&E data from the project
Feeding and other costs (Cell F125 to F129)	<ul style="list-style-type: none"> • Interviews with goat producers • M&E data from the project
Fattening period (Cell F131)	<ul style="list-style-type: none"> • Interviews with goat producers • M&E data from the project
Animal shelter (Cell F133 to F135)	M&E data from the project
Labor (Cell F137 & F138)	Interviews with goat producers
Weaning rate (Row 141)	Assumption based on the project targets
Does and bucks (Cell F145 & F146)	Optimal herd composition targeted by the project
Selling price increase due to intensive feeding (Cell F160)	Assumption
Macroeconomic Indicators	
US inflation rate (Cell F171)	IMF ³²
Price index – US (Cell F172)	Function of US inflation
Liberia inflation rate (Cell F173)	IMF
Price index – Liberia (Cell F174)	Function of Liberia inflation
Relative Price Index (Cell F175)	Function of US and Liberia price index
Official nominal exchange rate (Cell I177 to L177)	WB (http://data.worldbank.org/indicator/PA.NUS.FCRF)
Real exchange rate (Cell F178)	Base year : 2015
Change in real exchange rate (Cell I179 to L179)	Calculated based on the WB official exchange rates
Nominal exchange rate (Row 180)	Function of real exchange rate and relative price index
Discount rate (Cell F181)	USAID guidelines

³²<http://www.imf.org/external/pubs/ft/weo/2015/02/weodata/weorept.aspx?pr.x=36&pr.y=7&sy=2013&ey=2020&scsm=1&ssd=1&sort=country&ds=.&br=1&c=722&s=PCPIPCH&grp=0&a=>

EOCK (Cell F182)	USAID guidelines
FEP (Cell F183)	<p>Calculated based on the data extracted from:</p> <ul style="list-style-type: none"> • Government of Liberia Annual Fiscal Outturn Reports • Central Bank of Liberia Annual Reports